Exploring the frontiers of school environmental health and artificial intelligence for sustainability

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Abstract. This article examines the intersection of school environmental health and artificial intelligence (AI) in the context of sustainability. A bibliometric analysis was conducted using data from Scopus to explore publication trends, citation patterns, and thematic evolutions in the field. The study identifies key themes, influential authors, and significant publications shaping this area. Results show a strong focus on integrating AI in educational settings, highlighting the importance of sustainable practices in schools. The research emphasizes the role of AI in monitoring environmental parameters, managing energy resources, and supporting sustainable educational tools. Future research recommendations include further exploring the applications of AI in school environments for sustainability and health and investigating the potential of AI-driven educational tools in promoting sustainable behaviors among students.

1 Introduction

The growing concern for environmental health and sustainability has become a pivotal aspect of educational discourse, especially within the realm of school environments health and artificial intelligence (AI) [1–3]. This article embarks on a bibliometric analysis to explore the integration and evolution of school environmental health and AI within the context of sustainability. The purpose is to elucidate the trends, gaps, and future directions in this critical area of study.

Schools play a crucial role in shaping future generations, making the integration of environmental health practices essential [4–7]. The significance of creating healthy, sustainable school environments is not only beneficial for immediate health outcomes but also instrumental in instilling sustainable values in students [8]. Sustainability in education goes beyond environmental consciousness, encompassing economic and social dimensions as well [9,10]. This multifaceted approach underlines the importance of integrating sustainable practices in school settings for a holistic impact.

Bibliometric analysis serves as a powerful tool for mapping the landscape of academic research. By analysing publication patterns, citation networks, and thematic trends, this method provides a comprehensive overview of a research area's evolution [11–16]. This study aims to perform a bibliometric analysis on the scholarly works related to school environmental health and AI for sustainability. The objectives include identifying key themes, influential authors, and pivotal publications that have shaped the field.

Utilizing data from scopus.com academic databases, the study employs quantitative methods to analyses publication trends, citation patterns, and co-authorship networks in the literature. This approach enables a nuanced understanding of the field's trajectory. The relevance of this bibliometric analysis lies in its ability to inform educators, policymakers, and researchers about the current state and potential future directions of this critical field. By providing insights into research trends and gaps, this study is expected to contribute to the strategic planning of educational policies and curriculum development focused on environmental health and sustainable AI in schools.

2 Methods

This bibliometric analysis aims to dissect the research trends, key themes, and academic contributions in the field of school environmental health and AI for sustainability. The primary data for this study was extracted from Scopus, a comprehensive and versatile database known for its extensive coverage of scientific and educational literature. A carefully structured search query was developed, incorporating terms (TITLE-ABS-KEY (school AND environment) OR TITLE-ABS-KEY (school AND environmental AND health) AND TITLE-ABS-KEY (artificial AND intelligence) AND TITLE-ABS-KEY (ai)) to ensure the retrieval of

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relevant publications. The search using that query yielded 177 documents, as detailed in Table 1.

The data extraction process involved gathering information related to the publication year, authors, affiliations, geographic distribution, citation count, and keywords. This data was utilized to create a research landscape, identify significant contributors, and analyses trends over time. The research utilized the VOSViewer application [17] and Biblioshiny [18] for analysis purposes. This study will discuss the analysis of the interconnection of three fields using the Biblioshiny application, research trends based on keyword analysis using the VOSViewer application, and content analysis to enhance the understanding of school environmental health and AI.

Table 1. Main information about the data

No.	Description	Results
1	Timespan	1987:2023
2	Sources (Journals, Books, etc.)	131
3	Documents	177
4	Average years from publication	3.29
5	Average citations per documents	5.616
6	Average citations per year per doc	1.705

Thematic analysis was utilized to categorize the literature into predominant themes. This involved analysing keywords to discern major research focuses and how they have evolved over time. While bibliometric analysis provides valuable insights into academic trends, it has limitations, such as database biases and the exclusion of grey literature. Ethical considerations, such as the fair use of data and respect for intellectual property, were strictly adhered to throughout the research process.

3 Result and discussion

This research will address three comprehensive analyses aimed at understanding school environmental health and artificial intelligence for sustainability. This analysis is crucial as it aids in identifying the most influential keywords, journals, and authors in the field. It provides insights into key players and publication platforms, helping to understand where research is concentrated and who the primary contributors are.

Furthermore, analysing trends based on keywords reveals the evolving research focus over time. This aids in understanding how the emphasis on specific topics has shifted, highlighting emerging areas of interest and potential directions for future research. Subsequently, content analysis becomes essential for understanding how research content aligns with sustainable development goals. It evaluates the relevance and impact of research in contributing to sustainability, particularly in the context of school environmental health and AI.

3.1. Analysing the plots of the three fields

Figure 1. illustrates the analysis plots of three fields representing keywords-sources-authors. The analysis plots of these three fields, which include keyword (left), source (center), and author (right), depict the relationships among these three variables. The height of the boxes represents the volume of publications generated, and the thickness of the connecting lines illustrates the strength of the associations.

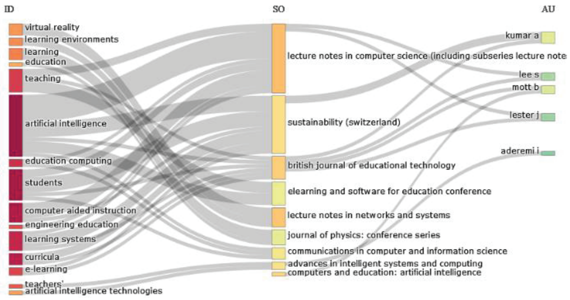

Fig. 1. Three-field plot representing keywords-sources-authors

Figure 1. suggests a robust interdisciplinary link between fields artificial intelligence, education, and engineering with educational technology publications in the context of AI. Key authors like Kumar A, Lee S, and Mott B have contributed to journals including the Lecture Notes in Computer Science, Sustainability, and British Journal of Educational Technology. The Figure 1. indicates that research in virtual reality, learning environments, and AI technologies is prominently featured in educational technology literature, highlighting the significance of these areas in current academic discourse.

3.2. The trend of themes based on keywords

The research theme trends in this article use co-occurrence analysis with a unit analysis of all keywords, with a minimum occurrence of keywords being 4 out of 1511, resulting in 59 keywords meeting the threshold. Figure 2 categorizes the keywords provided by the authors into five clusters, easily distinguishable by their colors. Keywords belonging to the same topic are gathered within one cluster identified by a different color scheme. The thickness of the lines depicts the strength of the relationships between keywords. The size of the circles represents the frequency of keyword occurrences; larger circles on the graph indicate a higher selection of keywords by researchers in the field of AI.

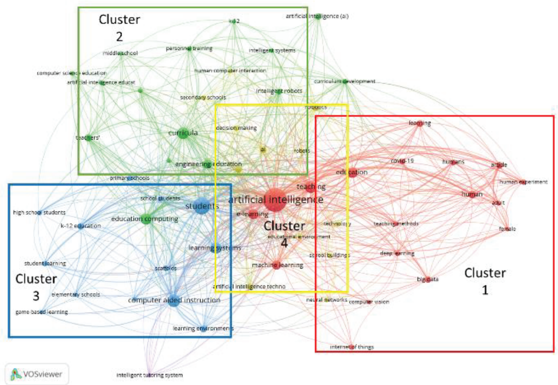

Fig. 2. Thematic trends based on the keywords of school environmental health and AI.

The keywords in Figure 2. suggest a strong focus on the integration of artificial intelligence (AI) in educational settings, particularly in relation to teaching methods such as computer-aided instruction and learning systems. The high occurrence and link strength of 'artificial intelligence' indicate its centrality to the current discourse, likely due to its potential to revolutionize educational practices. The presence of 'students,' 'teaching,' and 'curricula' implies a student-cantered approach to AI application, while 'education computing' and 'e-learning' reflect the digital transformation in education. 'Engineering education' and 'machine learning' may point to technical skill development for sustainability, and 'robotics' could be an indicator of interactive and applied learning. The data suggests a comprehensive approach, where AI is being woven into the fabric of educational systems to enhance learning environments, with a potential undercurrent of promoting sustainability within school environments.

3.3. Content analysis and its correlation with sustainability development

The intersection of school environmental health, AI, and sustainability is a conversation of paramount importance (see Figure 3.). It heralds a future where educational institutions not only impart knowledge but also embody the principles of a sustainable and healthful coexistence with environment [19].

In the realm of Monitoring and Analysis, the deployment of AI, with its of sensors and data analytics, is transformative [20]. Schools can now continuously monitor crucial environmental parameters like air and water quality, and even ambient noise and lighting conditions, ensuring they meet health standards. Such vigilant oversight is paramount for preemptive action and maintaining an environment conducive to learning and well-being [21].

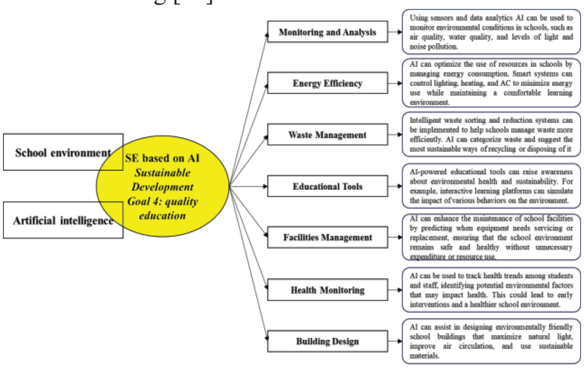

Fig. 3. AI-based school environment development framework for sustainable development goals.

When it comes to Energy Efficiency, AI is no less impactful. By judiciously managing energy resources, AI-driven systems can significantly reduce the carbon footprint of schools [22]. They can intelligently adjust lighting, heating, and air conditioning, striking an optimal balance between energy conservation and a comfortable learning environment this intersection of sustainability and cost-effectiveness is where AI truly shines [23].

Waste Management is yet another frontier where AI can make a substantial contribution [24]. By enabling efficient sorting and suggesting the most eco-friendly disposal methods, AI facilitates a greener school operation and instils sustainable practices in the school community [25].

The incorporation of Educational Tools powered by AI is a game-changer in environmental education [26–28]. Through engaging and interactive simulations, these tools can demonstrate the consequences of our actions on the environment [29–31], thereby raising awareness and fostering responsible behavior among students the future custodians of world.

In the sphere of Facilities Management, AI's predictive capabilities ensure the longevity and safety of school infrastructures [32]. By forecasting maintenance needs, schools can avoid unplanned downtime and excessive costs, keeping the educational process uninterrupted and secure. The role of AI in Health Monitoring cannot be overstressed [33]. By analysing health-related data, AI can uncover environmental risk factors affecting students and staff, prompting timely interventions [34]. Such proactive health management is crucial in maintaining a healthy school population.

Lastly, the potential of AI in Building Design is a testament to its role in sustainability [35]. AI can guide the creation of school structures that are not only environmentally sound but also enhance the learning atmosphere through improved natural lighting and air quality [36,37].

4 Conclusion

The discussion on educational development is always an intriguing research theme, vital for the continuity of education, integrating all aspects, including AI. This article emphasizes the crucial role of AI in enhancing the health and sustainability of school environments. It highlights AI's transformative impact in areas such as monitoring and analysis, energy efficiency, waste management, educational tools, facilities management, health monitoring, and building design. The conclusion underscores AI's potential in creating sustainable, healthy, and efficient educational environments, advocating for its integration into school systems to foster a sustainable development goals in the future.

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